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Insecta, Hymenoptera, Bethylidae: range extension and filling gaps in Yemen

Celso O. Azevedo
Bruno H. Guimarães

Universidade Federal do Espírito Santo, Departamento de Biologia, Av. Marechal Campos 1468, Maruípe, CEP 29.040-090, Vitória, ES, Brazil. E-mail: bethylidae@gmail.com

The family Bethylidae is widely distributed throughout the world, being found in all zoogeographic regions, but the majority of species occur in tropical areas (Azevedo 1999). Finnamore & Brothers (1993) estimated that these numbers do not represent more than 30% of the group's actual size. Until now only the species *Metrinotus szelenyii* Móczár, 1970 has been recorded from Yemen.

The present work's objective was to determine which genera of Bethylidae occur in Yemen, placing emphasis on geographic distribution data and their implications on the biogeographic status of the Arabian Peninsula.

Collections were performed monthly in different regions of Yemen from December 1999 to December 2002, using Malaise and light traps, in 16 localities in Yemen (Table 1). The material collected belongs to the Canadian National Collection of Insects (John T. Huber, curator).

Yemen is an Arab country occupying the southwest extremity of the Arabian Peninsula within the bounds of the Ethiopian region, according to the zoogeographic regions established by Wallace (1876). It is bordered in the north by Saudi Arabia, in the east by Oman, in the south by the Arabian Sea and the Gulf of Aden, across which lies the Somalian coast, and in the west by the strait of Bab el Mandeb, which separates it from Djibouti, and by the Red Sea, which separates it from Eritrea by just a few kilometers. The climate in Yemen varies according to the altitude, being tropical-arid in the north and tropical in the south. The average annual rainfall ranges from less than 50 mm in the coastal areas and the deserts to 200-400 mm on the slopes of the highlands and more than 1000 mm on the western slopes of the mountains. Temperatures are high all around the country, frequently reaching over 38° C on the coast. A desertic plateau occupies around three-fifths of the country's surface. The coastal plains are semidesertic and are fringed by islands, and in the center of the country there are mountainous regions with deep valleys and temporary rivers (extracted from http://www.fao.org/).

Table 1. Yemen localities where the Bethylidae specimens studied were collected.

Locality	Georeference
Ta'izz	13°34' N - 44°02' E
Al Kowd	13°05' N - 45°22' E
Sanhan	15°15' N - 44°20' E
Lahj	13°03' N - 44°50' E
Ja'ar	14°27' N - 44°15' E
Ar Rujum	15°26' N - 43°40' E
Al Lahima	15°24' N - 43°32' E
Madinat ash Shirq	14°38' N - 43°58' E
Suq Bani Mansour	15°06' N - 43°50' E
Al Kadan	15°16' N - 43°12' E
12 Km NW of Manakhah	15°05' N - 43°42' E
Zabid	14°11' N - 43°18' E
Seyun	15°55' N - 48°45' E
Yafa	14°33' N - 44°20' E
Sana'a	15°21' N - 44°13' E
Ghail Ba Wazir	14°46' N - 49°21' E

A total of 2,698 specimens was obtained and 17 genera were identified, distributed in subfamilies Pristocerinae, Epyrinae, Bethylinae and Mesitiinae (Table 2). All these genera are recorded for the first time from Yemen, with the exception of genus *Metrionotus* Móczár. Most of the genera found in Yemen have a cosmopolitan distribution, such as *Apenesia* Westwood, *Rhabdepyris* Kieffer, *Epyris* Westwood, *Goniozus* Förster, *Holepyris* Kieffer, *Plastanoxus* Kieffer and *Cephalonomia* Westwood, or are widely distributed, such as *Pseudisobrachium* Kieffer, *Dissomphalus* Ashmead and *Parascleroderma* Kieffer, which have been reported from all zoogeographic regions of the world with the exception of the Australian region. Genera *Bethylus* Latreille and *Laelius* Ashmead are restricted to the northern hemisphere, whereas *Pristocera* Klug, *Sulcomesitius* Móczár and

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Metrionotus are restricted to the Old World, the last two genera having never been reported from the Australian region; and *Discleroderma* Kieffer is restricted to Oriental region. Of the genera found herein, the only one restricted to a single zoogeographic region is *Clytovorus* Nagy. This is a genus with only six species, recorded so far in Europe and North Africa, more precisely in Morocco, and thus confined to the western part of the Palaearctic region. Genera *Apenesia*, *Clytovorus*, *Rhabdepyris* and *Sulcomesitius* are here cited for the first time for the Arabian Peninsula. The other genera were already known from the Peninsula, especially from its northern region, mainly Israel and Syria.

Most genera occurred in low relative abundance, but *Epyris* was found in a large series, representing ⅓ of the total sampled. *Goniozus*, *Holepyris* and *Pseudisobrachium* presented intermediate relative abundances (Table 2).

Table 2. Quantity and relative abundance of the Bethylidae genera found in Yemen during the study.

Genera	Total	%
Epyris Westwood	910	33.72
Goniozus Förster	480	17.79
Holepyris Kieffer	383	14.19
Pseudisobrachium Kieffer	340	12.60
Pristocera Klug	219	8.11
Laelius Ashmead	135	5.00
Dissomphalus Ashmead	111	4.11
Parascleroderma Kieffer	46	1.70
Cephalonomia Westwood	38	1.40
Metrionotus Móczár	14	0.51
Sulcomesitius Móczár	08	0.29
Plastanoxus Kieffer	05	0.18
Apenesia Westwood	04	0.14
Discleroderma Latreille	02	0.07
Bethylus Latreille	01	0.03
Rhabdepyris Kieffer	01	0.03
Clytrovorus Nagy	01	0.03
Total	2698	100

Based on the Bethylidae zoogeographic distribution data herein obtained, the genera occurring in Yemen may be classed thus:

- Exclusively Palaearctic genus: *Clytrovorus*.
- Exclusively Oriental genus: *Discleroderma*.
- Cosmopolitan or widely distributed genera: *Apenesia*, *Pseudisobrachium*, *Dissomphalus*, *Goniozus*, *Sclerodermus*, *Rhabdepyris*, *Epyris*, *Holepyris*, *Plastanoxus* and *Cephalonomia*.
- Genera common to both the Ethiopian and Palaearctic regions (not considered cosmopolitan): *Pristocera*, *Parascleroderma*, *Metrionotus* and *Sulcomesitius*.
- Genera occurring in the Palaearctic region (not exclusive to this region) which do not occur in the Ethiopian region: *Laelius* and *Bethylus*.

Our data indicate that there may be an exchange of bethylid fauna between the Palaearctic part of Eurasia and the Mediterranean part of Africa via the Arabian Peninsula, where Yemen is located. This exchange does not occur between the Mediterranean and Ethiopian parts of Africa, areas separated by The Sahara Desert and up to the present lacking in considerable records of bethylids cited. The Sahara Desert poses a great barrier to dispersion, and divides Africa's fauna into Palaearctic and Ethiopian. The bethylid composition on the Palaearctic part of Africa is quite distinct from the Ethiopian composition. On the other hand, the Mediterranean part presents similarities to the composition found in Yemen.

The Bethylidae from Yemen herein identified may be an indication that the Arabian Peninsula is characteristically Palaearctic in its faunal composition, and not Ethiopian, since all genera collected in Yemen occur in the Palaearctic region, including the genus *Clytrovorus*, which is endemic to the latter region, as well as genera *Bethylus* and *Laelius*, which are not cited for the Ethiopian region. On the other hand, Yemen did not present genera endemic to the Ethiopian region, sharing only 14 of the 17 genera with it. These data suggest that it might be better to consider the entire Arabian Peninsula as belonging to the Palaearctic region, thus corroborating the ideas of Cox (2001).

Kimsey & Bohart (1990) also used a zoogeographic classification that includes Yemen in the Palaearctic region. This classification reflects the distribution of species of family Chrysididae,

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sister family to Bethylidae, since the Chrysididae fauna found in all of Saudi Arabia, Yemen and Oman presents affinities with the Palaearctic fauna, as opposed to the Ethiopian fauna.

Some authors (e.g. Wallace 1876; Morrone 2002) adopted a zoogeographic classification that includes the Arabian Peninsula in the Ethiopian region. If that is so, the genera *Laelius*, *Bethylus* and *Clytrovorus*, previously cited for the Palaearctic and not the Ethiopian region, are here cited for the first time for the Ethiopian region, and the last genus ceases been exclusively Palaearctic.

The presence of Oriental genus *Discleroderma* in Yemen also emphases the connection of Arabian Peninsula to Oriental region. Plant species analyses suggests that Oriental area of Arabian Peninsula belongs to Oriental region (Takhtajan 1986; Moore 1991)

According to Olmi & van Harten (2000), in Yemen occur ten species of Dryinidae, one of Embolemidae and two of Sclerogibbidae. The first family is large and common, while the others are smaller and rarer, and together with family Bethylidae integrate superfamily Chrysidoidea (Brothers & Carpenter, 1993). Before this study, records existed only for one species of Dryinidae, one of Embolemidae and one of Sclerogibbidae. Among Chrysidoidea families, Bethylidae is the one with the highest undiscovered biodiversity potential (Azevedo 1999). Supporting this affirmation is the fact that, in a first systematic attempt to study the bethylid fauna in Yemen, 17 genera were collected, which implies that at least 17 species occur in the country. This is relatively significant, since Olmi & van Harten (2000) cited the occurrence of 13 species of Dryinidae, Embolemidae and Sclerogibbidae combined for the same region.

In spite of being located in an arid territory with little rainfall, Yemen presents a great potential of bethylid diversity, when compared, for instance, with the 21 genera that occur in Brazil, a country of continental dimensions with a greater variety of ecosystems, where many collections and studies have already been undertaken.

The fact that 17 genera of Bethylidae were found in Yemen as a result of a first systematic collection, 16 of which cited as first occurrences, evidences our enormous lack of knowledge about these parasitoid wasps in that area and the need for a more intense sampling effort, an effort which ought to be extended to other areas of the planet as well.

The lack of worldwide systematic collecting limits the improvement of the distribution data on these wasps, which often seem to be restricted to specific regions of the planet. Hopefully, in the future such research will be encouraged in Yemen, since as part of the Arabian Peninsula it constitutes an important zoogeographic bridge between Africa and the Palaearctic region, as already noted by Olmi & van Harten (2000) for families Dryinidae, Embolemidae and Sclerogibbidae.

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